Safe Zones for Miniscrew Insertion among Nepalese Population: A cadaveric study

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Abstract

Introduction: Anchorage plays very important role in executing orthodontic treatment planning and achieving ideal goal. With the use of mini-implant, the job of orthodontists to control anchorage has been easier. Several radiographic, cone beam CT and histopathological studies have been performed to assess the safe locations in the interradicular spaces for miniscrew placement, the so-called ''safe zones.' The aim of the study is to determine safe zones for miniscrew placement among Nepalese population.

Methods: Cross sections of adult cadaver jaws were analyzed in 16 mandibles and 16 maxillae after decalcification. Direct measurements were done both in mesio-distal and bucco-lingual directions with the use of digital vernier caliper at 2 mm, 5 mm, 8 mm and 11 mm cut levels from the cervical line in posterior regions of the jaws.

Results: Generally interradicular distance measured greater than 3mm at all levels except at 2mm where the measurement varied considerably in both jaws. All the bucco-lingual measurements in maxilla were above 7 mm except at 2 mm level where the measurements varied. The average bucco-lingual distance measured between 6.52 mm to 9.63 mm in mandible. Generally, all the dimensions measured increased upon moving apically and distally except at 11 mm level between first and second premolar region.

Conclusion: At the buccal aspect of the posterior region of both jaws, the optimal sites are between the second premolar and the first molar and between the first and second in agreement with most of the studies done earlier.

Key words: Anchorage, Miniscrews, Minimplant screws, orthodontics

Introduction

Anchorage plays very important role in executing orthodontic treatment planning and achieving ideal goal. Orthodontists have been using teeth, jaws, soft tissues and even head and neck for control of anchorage. However, it has always been difficult to achieve absolute anchorage as well as obtain patient's co-operation while prescribing extra-oral anchorage system.

With the use of mini-implant[1,2,3,4,5,6,7,] the job of orthodontists to control anchorage has been easier. The increase in the popularity in the use of miniscrews is because of simple placement and removal procedures, affordable cost, and for allowing the application of relatively simple force systems[8,9]. However, because of limited interradicular space, damage of dental roots has been reported[10,11,12,13]. Orthodontists have developed different guides and guidelines[14,15,16] for placement of miniscrews in the interradicular regions in order to prevent these damages. However, sufficient amount of bone between the roots of the adjacent teeth is the most important factor for the placement of miniscrews without causing damage to the bone. Minimum of 1mm bone is recommended on either side of the Miniscrew in order to have a safe placement[17].

Several radiographic, cone beam CT and histopathological studies have been performed to assess the safe locations in the interradicular spaces for miniscrew placement, the so-called ''safe zones[17,18,19,20,21,22,23,24,25,26,27]. Almost all these studies were conducted using radiography or computerized tomography. Only Hu et al[24] from South Korea did histopathological study to determine the safe zones for miniscrew placement in mandible and maxilla in 2009. However, so far no study is done in Nepalese population in this regard and we are compelled to extrapolate the result of studies done in other countries. Hence, this cadaveric study was conducted to determine safe zones for miniscrew placement among Nepalese population and to verify if space between second premolar and first molar, and the space between first and second molars in the mandible is adequate for miniscrew placement.

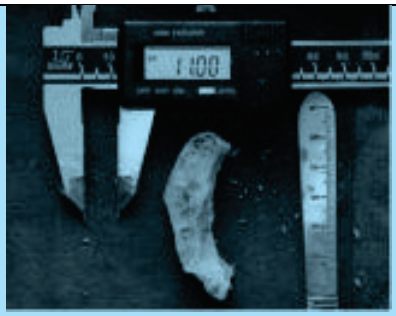
Methods

The study was conducted in Orthodontic PG Section, Department of Dentistry and Department of Forensic Science, TU Teaching Hospital, Institute of Medicine, Kathmandu, Nepal. Ethical approval was obtained from Institutional Review Board, Institute of Medicine, Tribhuvan University, Kathmandu, Nepal.

Cross sections of adult cadaver jaws were analyzed in 16 mandibles and 16 maxillae. Right and left halves were considered as separate study units. Cadavers with full complement of teeth from second molar to second molar with intact occlusal plane were selected. Any specimen with bone pathology was discarded. The mandibles and maxillae were decalcified in 10% Nitric Acid in distilled water for 4 to 7 days and then neutralized in distilled water for 24 hours.

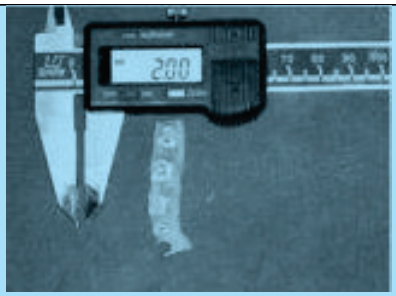
The decalcified mandibles and maxillae were cut serially at 2mm, 5mm, 8 mm and 11 mm intervals from the Cervical line parallel to the occlusal plane towards the root apex with the use of an autopsy blade (#170 Feather Safety Razor, Osaka, Japan). Photographic images of some of the cut sections are given in the figure 1, 2.

Cross section of Maxilla at 8mm from Cervical line



Cross section of Maxilla at 11mm from Cervical line

Figure1: Examples of cut sections in Maxilla



Cross section of Mandible at 2mm from Cervical line

Cross section of Mandible at 5mm from Cervical line

Figure 2: Examples of cut sections of mandible at 8 and 11mm levels

The bucco-lingual thickness and interradicular distance were measured at above mentioned four sectional areas using digital vernier caliper by the Principal investigator.

Statistical Analysis

The statistical analyses were performed using the SPSS program, version 17 (SPSS Inc, Chicago, Ill). Mean, standard deviation and range of the measurements were calculated. The measurements from the right and left sides were averaged following Lee et al[23], as they found no statistical difference (P 0.05).

In this study, all measurements were made by a single examiner to confirm the reliability of the data. The measurements were repeated for 10 randomly selected sections with a 1-week interval, to assess intra-observer reliability, which showed no statistical differences (P.0.05) from the paired t test.

Results

The result of Interradicular distance and buccolingual bone thikness at various levels of postterior maxilla is summarized in table 1, where as the same for the mandible is summarized in table 2.

Table 1: Interradicular and Bucco-lingual bone distance at various levels in Maxillae.

Maxilla: (N=32)	Interradicular distance				Bucco-Lingual bone thickness			
	2mm	5mm	8mm	11mm	2mm	5mm	8mm	11mm
Between 1st and 2nd premolar								
Mean	2.61	3.48	3.49	3.74	2.54	7.73	7.73	10.34
SD	.03	.04	.03	.04	.05	.04	.04	.04
Range	.11	.12	.12	.12	.13	.13	.13	.13
Between second premolar and 1st molar								
Mean	3.93	3.44	3.52	4.56	2.14	8.04	8.02	11.92
SD	.93	.58	.47	.51	.10	.30	.30	.67
Range	2.67	2.26	1.60	1.89	.37	1.45	1.47	2.30
Between first and second molar								
Mean	3.36	4.54	4.68	5.60	2.43	10.14	10.08	12.67
SD	.25	.51	.38	.35	.42	.53	.61	.80
Range	.67	1.86	1.10	1.18	1.14	1.65	2.02	2.92

Table 2: Interradicular and Bucco-lingual bone distance at various levels in Mandibles.

Mandible: (N=32)	Interradicular distance				Bucco-Lingual bone thickness			
	2mm	5mm	8mm	11mm	2mm	5mm	8mm	11mm
Between 1st and 2nd premolar								
Mean	2.27	2.89	3.29	3.35	5.74	6.52	6.84	7.28
SD	0.53	0.64	0.58	0.61	2.11	1.51	1.92	2.65
Range	2.09	1.98	1.93	2.34	6.19	5.75	6.51	7.33
Between second premolar and 1st molar								
Mean	2.64	2.86	3.24	3.42	6.36	6.94	7.64	8.19
SD	0.69	1.01	0.75	0.68	2.14	1.93	1.85	2.52
Range	2.40	4.50	2.60	2.50	6.89	7.86	6.49	8.42
Between first and second molar								
Mean	3.25	3.40	3.61	4.66	8.01	8.74	9.63	9.63
SD	.85	.99	1.03	1.16	2.67	2.36	1.99	2.47
Range	3.50	3.18	2.92	3.41	8.69	7.92	6.10	8.05

Interradicular distance:

Maxilla:

- Interradicular distance measured above 3 mm in all cut sections except at 2 mm level between first premolar and second premolars.

Mandible:

- Interradicular distance measured less than 3 mm at 5mm level between first premolar and second premolar
- Interradicular distance measured less than 3 mm at 5mm level between 2nd premolar and first molar region.
- Interradicular distance measured more than 3 mm in all other areas above 5 mm level.

Bucco-lingual Bone thickness:

Maxilla:

- The average bucco-lingual distance measured between 2.14 mm to 12.66 mm in maxilla. All the measurements in maxilla were above 7 mm except at 2mm level.
- Generally, all the dimensions measured increased upon moving apically in maxilla.
- Except at 2mm level, all the dimensions increased moving distally.

Mandible:

- The average bucco-lingual distance measured between 5.74 mm to 9.63 mm in mandible.
- Generally, all the dimensions measured increased upon moving apically and distally.

Discussion

Although various types of implants have been used for ideal orthodontic anchorage, miniscrews have passed the test of time and is ever becoming popular because of its low cost and ease of insertion. The success of mini-implant screws depends on various factors. Some of these factors are implant related (type, diameter, and length of the implant), patient related (sex, age, physical status), surgical related (direction of mini-implant placement and placement torque), orthodontic related (magnitude and timing of force), location related (peri-implant bone quantity, cortical bone thickness, keratinized versus oral mucosa), and implant-maintenance related[28]. Although the exact role of these factors is not fully understood28, the interradicular distance and the bucco-lingual distance are important factors for the

success of mini-implant screw usage. Miniscrews typically have diameters ranging from 1.2 to 2 mm and lengths of 6, 8, and 10 mm21. A minimum clearance of 1 mm of alveolar bone around the screw is recommended by Poggio et al for insertion of miniscrew without damage to the periodontal tissue and the root[17]. According to this guideline, a minimum of 3 mm interradicular space is needed for insertion of miniscrew. As such in order to define the safe zones for the insertion of miniscrews, various studies have been carried out using panoramic radiographs, CT, micro-CT and histo-sections[17,18,20,21,29]. The present study investigated the anatomic data gathered from direct measurement of 16 mandibles 16 maxillae of cadaver to determine the optimal sites for mini-implant placement in posterior regions by studying two factors: interradicular bone dimensions and bucco-lingual bone thickness. In this study the cervical line was selected as the starting point for the measurements, unlike other studies[17,25] that used the alveolar crest, which could be affected by different periodontal problems.

It is advisable to place the mini-implants in areas of attached gingiva[30]. Lim et al[31] excluded levels higher than 6 mm in their study on interradicular soft tissue for the same reason. However, when the miniscrew is to be placed at an angle, evaluation of interradicular bone at a higher level is also beneficial.

This study shows that interradicular distance is adequate (3mm or greater)(17) apical to 5mm level in all posterior buccal regions of maxilla and mandible studied except at 5 mm level between mandibular first premolar and second premolar, and second premolar and first molar region. These findings were found to be in agreement with those obtained in other similar studies[17,19,21,24,26] except for the regions between first and second premolars in the mandible. In this region, interradicular distance is safe only above 8 mm level. When considering the placement of miniscrew in the bucco-lingual direction, 7 mm long miniscrews could be placed safely apical to 5mm level even in horizontal direction in maxilla; whereas shorter miniscrews should considered in mandible. 8 mm long miniscrews can be safely placed in areas between second premolar and first molar as well as between first and second molars above 5 mm level in maxilla. However, in mandible, 8mm miniscrews are safe an all areas apical to 5 mm level between first and second molars.

Conclusion

At the buccal aspect of the posterior region of maxilla, the optimal sites are between the second premolar and the first molar and between the first and second molars. In mandible, optimal sites are between first and second molars.

Recommendation

The mean values of safe zones at various levels are presented here. Considering the ranges in the data table, it is always advisable to use a radiograph to assess the interradicular distance as well.

Cortical bone thickness and soft tissue thickness is not considered in the study, hence separate study is recommended.

Similar study in the anterior regions is also recommended.

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